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AUTOMATED THEMATIC MAPPING AND CHANGE DETECTION OF ERTS-A IMAGES

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16. Abstract

This investigation is concerned with the development of automated interpretation techniques for the recognition and identification of earth resources. The resources will be identified by using both multispectral and spatial signatures. Ground truth data and aircraft underflight photography will be used to train the recognition algorithms. The data processed will be RBV and MSS images acquired by the ERTS-1 satellite, over six test sites located in the vicinities of: Phoenix, Arizona, Weslaco, Texas, Cascade Mountains, Washington, New Orleans, Louisiana, Salt Lake, Utah and Salton Sea, California. The processed data will be thematic maps of resources consisting of annotated and outlined images. The seasonal changes of hydrologic and agricultural resources will also be identified. The results are expected to be applicable to a future automatic system of resource inventory and management.

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Discussion

During the reporting period, work continued with the analysis of ERTS-1 image 1049-17324 which covers an area in southern Arizona near Phoenix. Initial attempts to process the digital data of this image through our Pattern and Terrain Classification Software system failed. Then, detailed analysis of the data showed the presence of noise which was responsible for the failure of the algorithms to recognize reliably the various terrain types. Once the noise was discovered, it was quickly traced to small calibration errors of the MSS detectors (there are six detectors per spectral band). We filtered the noise in the Fourier domain and proceeded to develop new signatures for the various terrain types. Finally, the data was subjected to automatic terrain recognition by the modified PTCS software. The recognition results for most terrain types were very good: 97% for desert, 89% for farms, 80% for mountains, 74% for urban areas, 98% for clouds, 100% for water, 81% for cloud shadows. Only, river flood plains which are peculiar geographic features of southern Arizona were recognized poorly (11%). The accuracy of recognition was determined by comparison to existing maps, high altitude (U-2 missions on Sept. and Dec. 1971) and low-altitude aerial photography (mission 212 of the Earth Resources Aircraft Program, from the Manned Spacecraft Center in Houston, Texas). The accuracy of the cloud recognition was determined by photointerpretation of the ERTS image since the aerial photography was obtained on different dates.

The automated recognition of terrain types was described in a paper given to the ERTS-1 Symposium of March 5-9, 1973 sponsored by NASA/GSFC. The title of this paper is "Terrain Type Recognition Using ERTS-1 MSS Images".

At the Symposium, we were able to compare notes with other investigators. It appears that this investigation (Contract No. NAS5-21766) has contributed the following significant but not necessarily unique results toward the interpretation of the ERTS-1 digital data:

a. <u>Digital data from adjacent areas on the ground were retrieved from two digital tapes and combined into a single digital image.</u> This is a data handling operation that facilitates processing of contiguous areas simultaneously. Most investigators processed and displayed the data from each type separately. The displayed images must then be joined together as in a photomosaic. Digital mosaicking was mentioned by Billingsley and Goetz (Paper I9).

b. <u>The scales of the digital data in the scanning and cross-scanning directions were equalized.</u> In the Computer Compatible Tapes there are more samples per kilometer in the scanning direction than in a direction normal to the scan lines. Then, the scales in these two directions are different. To equalize the scales, one must interpolate and resample each scan line of data. If the scales are not equalized, errors develop in the interpretation of terrain types. Most investigators had not equalized the scales and had difficulties comparing ground truth data to the interpretation results. The different scales distorted the color coded agricultured resource maps which appeared as if they were made from oblique aerial photography rather than from a vertically pointing system. Scale equalization was mentioned by Billingsley (Paper I9) and Rifman (Paper I6).

c. The interpretation results were displayed as annotation superimposed on the ERTS-1 image. The annotation and the ERTS-1 image were recorded simultaneously in the Itek Laser Beam Recorder from a digital format. By this method, perfect registration of the annotation to the image is achieved. The superposition of the interpretation results on the ERTS image enhances their utility since an observer will be able to easily associate the recognized resources with their locations on the ground. There was no indication that other investigators were using high resolution recorders to produce annotated images. Some investigators were using alphanumeric symbols printed on lengthy rolls of paper. More effective displays were color coded resource maps from CRT displays. These, however, lacked annotation and/or other means of being quickly related to geographic features.

d. Very significant signatures of terrain types were discovered in the Fourier transforms of small blocks of ERTS data. The signatures for cultivated land and urban areas are readily obvious in diffraction patterns obtained from ERTS transparencies. At the symposium these signatures were of interest to several other investigators. Other investigators did not appear to be using the Fourier transforms to extract features for automatic recognition.

e. The MSS calibration noise was removed from the Fourier transforms. The noise was clearly shown in the diffraction patterns and the Fourier transforms presented at the symposium. The noise was removed and did not affect the terrain recognition process. Cousin (Paper I8) and Billingsley (Paper I9) presented two methods of filtering the noise from the image. However, other investigators had not removed the noise and experienced significant errors in the recognition of terrain types or "texture".

Also, during the reporting period, we attempted to produce automatically, earth resource boundaries for image 1049-17324 using an edge detection software system. This effort had a partial success and more work is needed in order to generate accurate boundaries reliably.

For the next reporting period, we are planning to utilize the multispectral information in the ERTS images for the purpose of increasing the accuracy of terrain recognition and for the development of accurate boundaries between the various terrains.